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Report of the Planning Group on the HAC Data Exchange Format (PGHAC)

By Correspondence



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1 Executive Summary

The Planning Group on the HAC Data Exchange Format (PGHAC) has worked by correspondence since the 2004 meeting. Laurent BERGER (France) reported as Chair of PGHAC at the ICES Working Group on Fisheries Acoustics Science and Technology (WGFAST) meeting (held at the United Nations Food and Agriculture Organization (FAO) Headquarters in Rome, Italy, 19–22 April 2005).

The following main results have been achieved:

- the “DESCRIPTION OF THE ICES HAC STANDARD DATA EXCHANGE FORMAT, VERSION 1.60” document has been completed and reviewed, and this final version should be published as an *ICES Cooperative Research Report* in the next months.
- small modifications have been made to multibeam tuples proposed in PGHAC04, these tuples will be soon stabilized and will be detailed in next PGHAC report (PGHAC06), these tuples will be dedicated to the new calibrated Simrad multi-beam systems still under development, and a reflection needs to be conducted for the need of supporting other existing multibeam echosounders.
- the compatibility of sounder manufacturer and post-processing software to HAC format has been reviewed.

Discussions on the use of HAC format for exchanging fisheries acoustics data and for comparing processing algorithms within the ICES community has been discussed:

The use of the HAC format in the SIMFAMI (Species Identification Methods from Acoustic Multifrequency Information) project, funded by the European Commission has been discussed. Despite the implementation problems encountered within SIMFAMI project, the HAC format has proven to be efficient for exchanging acoustic data amongst the following institutes: FRS Aberdeen Scotland; IMR, Bergen Norway; IRD, Brest, France; IFREMER, Nantes, France; IEO, Palma de Mallorca, Spain; and IEO, Madrid, Spain. With the production of a reference document for the format and the experience gained in the SIMFAMI project it will be much easier in the future.

The group will continue to work by correspondence to address the following topics:

- Review the final version of tuples for multibeam echosounders;
- Review the development of a tuple for acoustic trawl geometry instruments;
- Review the compatibility of sounder manufacturer and post-processing software to HAC format.

If needed, the PGHAC will meet during next WGFAST meeting in Hobart, Tasmania, in March 2006.

2 Terms of Reference

The Terms of Reference for the Planning Group on the HAC Data Exchange Format (PGHAC) as approved at the ICES Annual Conference, Vigo, Spain, September 2004 were:

- a) coordinate the further development of the HAC standard data exchange format;
- b) provide information on the changes in the format and its evolution;
- c) share information between manufacturers and users on the way acoustic data are processed and stored;
- d) review the new collated HAC specification manual;
- e) review the development of tuples for multi-beam echosounders.

As agreed, the PGHAC worked by correspondence to address these terms of reference.

The following main topics have been addressed and will be detailed in this document:

- Production of the new collated HAC specification manual (ToR b and d);
- Update of tuple definition and allocation (ToR a and e);
- Review of the compliance of sounder manufacturer and the compatibility of post-processing software to HAC format (ToR c).

A list of people currently involved in HAC standard format is attached in Annex. The list of PGHAC members will be updated in the next few months taking into account the possibility of appointing experts who are not appointed by national delegates.

3 Introduction

In 1999, WGFAST (meeting in St. John's, Newfoundland) adopted the *HAC* standard data format for raw and edited hydroacoustic data (Simard *et al.*, 1997; 1999) as the common format for exchanging fisheries acoustics data and for comparing processing algorithms within the ICES community (ICES CM 1999/B:2: Section 10.3, p. 12). A group of experts including WGFAST members and representatives of hardware and software manufacturers was assigned the responsibility of coordinating the development of the format. This included the examination of proposals to introduce new information in the *HAC* environment and the definition of a generic set of tuples for echosounders that were not covered by the already defined tuples* of this upgradeable format. At the WGFAST in Haarlem, Netherlands, it was agreed that this was a major issue of importance to all members of the fisheries acoustic community and that a more permanent group should be set up. This was proposed at the ASC in Bruges, Belgium (September 2000) and was formally incorporated as an ICES Planning Group (PGHAC, ICES Annual Report for 2000. Part 3. p. 256).

4 Subjects addressed

4.1 Production of the new collated HAC specification manual

The draft version of the document proposed in 2004 has been completely reviewed. This revision has led to the document entitled "Description of the ICES HAC Standard Data Exchange

* **Tuple:** a labelled group of bytes encapsulating special type of information in the *HAC* format, which forms the basic structure of this format and that, gives the format its upgradeability and versatility property. Tuples belongs to tuple families or classes that group the information by themes. Unique numbers, varying from 0 to 65535, identify each tuple. The *HAC* co-ordinating committee has to allocate these numbers to prevent any "collision" in the tuple usage by various groups around the world and to agree on the definition of the various fields of information they contain.

Format, Version 1.60”, written by Ian McQuinn and collaborators. The document collates and summarises the work achieved by PGHAC since 2000 into a coherent, usable description of the format. Based on the document produced by the original workshop held at the Maurice Lamontagne Institute on 12–14 December 1995, an effort has been made to explain the file structure, to state the general syntax rules for the format, to define several levels of tuples (from minimum to basic to optional) and to layout the rules for the definition of new tuples. An example of the file structure has been added to help developers to implement the format.

With this document, the format will be able to evolve in the future to adapt to the advances in fisheries acoustics within a well defined and documented framework. This document will be published in the next few months as an *ICES Cooperative Research Report* and made available on the ICES web site. It is already available by request to PGHAC.

The important modifications on the document since the 2004 draft version are the following:

4.1.1 Definition of angles in HAC

Following Jon Preston’s helpful comments on the description and definition of angles, all angle and axis orientation variable definitions in HAC format have been revisited. These definitions have been illustrated and summarized in annex of the new document.

This revision has been done with two constraints:

- to define variables in mathematically right-handed systems;
- to be consistent as much as possible with existing definitions in HAC.

In order to resolve the apparent inconsistency between the vessel roll or the athwartship installation angle definitions (positive port side up) and the athwartship beam steering angle definitions (positive when the down propagating beam is oriented to starboard), we used two different references for the coordinate systems to define on the one hand the vessel attitude and the transducer installation and on the other hand the beamforming.

These definitions are compatible with the coordinate system used by Simrad to define steering angle. This TX/RX coordinate system can be seen as a sonar TX/RX coordinate system adapted to a sounder with a -90° rotation around the y axis of the vessel coordinate system.

Once all the angles were mathematically defined in right-handed systems, we specified the variables in the standard coordinate system with the x-axis positive forward, the y-axis positive to starboard, and the z-axis positive down.

4.1.2 Definition of environmental tuple

The definition of STD profile tuple (11000) has been detailed and approved by the group to include fields for vertical profiles of pressure, temperature, conductivity, sound velocity, depth, salinity and absorption.

If a fixed sound speed (independent of depth) is used, the value can be stored in the Echo-sounder tuple.

4.1.3 Explanation on range calculation

As stated in the 2004 report the following explanation of the range calculation of a single target has been added as a note in the description of the “Range (Target #1)” field of split-beam detected single-target tuple (10090).

The Simrad EK500 and EK60 echosounders output “Depth” to the target relative to the surface, i.e., $\text{Range} = \text{Depth to the target} - \text{transducer depth} - \text{heave}$. The EK60 estimates the front edge of the echo (d), i.e., will seldom be an integer multiple of sample intervals, and is

*given by the equation: $d=x-2*s$, where s is the sample interval (and $2*s$ is half of a pulse length) and x is the centre of gravity of the target as estimated from the raw power samples (i.e., no TVG) according to the equation: $x=\Sigma(pi*ri)/\Sigma(pi)$, where pi is the linear power value of sample i and ri is the range to sample i . i ranges from -2 to 2, where $i=0$ refers to the position of detected peak for the current single target. The closest TVG (40log) value is used to calculate the TS value.*

Additional comments were made on this topic concerning the error on range calculation due to the unknown system delay based on:

- the unknown start of receiving time compared to the transmitting time;
- the shape of the pulse taking into account the bandwidth.

These comments have not led to modifications of the format since these parameters appear to be internal parameters that have to be clarified with Simrad. If it appears that these parameters will be quantifiable in the future for the EK60, the format is flexible enough to use the offset field of the channel tuple for a possible offset in the range.

4.2 Update of tuple allocation and definition

4.2.1 Modifications to existing standard tuples

Clarifications in the coordinate systems in the new HAC standard document have led to modifications/clarifications in the description of the following tuples:

- 1000 and 1001 Biosonics channel tuples
- 2000 and 2001 Simrad EK500 channel tuples
- 9001 Generic channel tuple
- 41 and 42 Platform parameters
- 10140 and 10142 Platform attitude

The new standard document for the HAC format contains the updated definitions of these tuples. The angle and offset standardized definitions are summarized in a table in Annex 2 of this new document.

4.2.2 Modifications to new temporary multibeam tuples

Small modifications have been made in the sounder tuple (220) and channel tuple (2200) in order to take into account the evolution of the sounder during the development of the equipment at Simrad.

Due to some delay in the sounder development, this version of the multibeam tuples is not definitive. The allocated 14 months for the definition of these tuples will be extended and finalised versions of the three multibeam tuples (220, 2200 and 2210) will be agreed upon by correspondence by the members of PGHAC with SIMRAD & IFREMER. These will be included in the 2006 report of the PG.

These tuples will be dedicated to the new calibrated Simrad multibeam systems, although HAC support for other existing multibeam echosounders has to be considered.

4.2.3 Update of basic tuple list

The following tuples have been added to the HAC standard basic tuple list:

- 210 EK60 Echo sounder tuple
- 2100 EK60 Echo channel tuple
- 11000 STD profile tuple and more generally, environmental tuple class [Reserved tuple type codes: 11000 – 11999].

The new standard document for the HAC format contains the updated lists of standard tuples and their definitions.

4.3 Review of the compliance of sounder manufacturer and the compatibility of post-processing software to HAC format

A data file is defined as *HAC* compliant if it conforms to the *HAC* syntax rules, contains the minimum required *HAC* tuples described above using the exact tuple format described (Simard et al 1997 and subsequent updates).

A software application tool is defined as *HAC* compatible if it can read and/or write, and use a minimum number of commonly used basic tuples, in the little endian format used by PC platforms.

4.3.1 Compliance of sounder manufacturer

4.3.1.1 SIMRAD

The ER60 is exporting data into HAC files since version 2.1.0 (October 2004).

The ER60 outputs the following tuples:

- 65535 HAC signature
- 20 Standard position
- 210 Simrad EK60 echo sounder
- 2100 Simrad EK60 channel
- 10030 Ping U-16
- 10031 Ping U-16-angles
- 4000 Single target parameter
- 10090 Single target ping
- 65534 End of file

This output has been tested by Ifremer and DFO.

The following remaining points are requested of Simrad:

- Output of a threshold tuple to comply with the minimum list of tuple required in the format;
- If no single targets are detected then no single target ping should exist;
- Output of platform parameter and platform attitude tuples;
- Ability to choose the file cutting in the ER60 interface as for the raw data files.

These points will be implemented in a next version of ER60.

4.3.1.2 MARPORT

The MARPORT Company has decided to use the HAC format for their new wireless netsonde under development.

Temporary sounder and channel tuples (600?) and (6000?) have been allocated to MARPORT for their development .

A new temporary tuple for acoustic trawl geometry (50?) was also allocated (vertical and horizontal opening, headrope and footrope positioning, temperature at trawl, trawl filling ...), in response to a need expressed by the group in 2004. A proposal will be made by IFREMER to the rest of the group in the course of the year. This tuple will be used by MARPORT for their trawl instruments.

4.3.1.3 FURUNO

Commercial brochures of the Furuno FCV 30 echo sounder present a “HAC scientific data output”, although up to now, no contact from FURUNO have been made on this topic. This output needs to be validated.

4.3.1.4 BIOSONICS

Following the last WGFAST meeting in Gdynia, contacts were made between BIOSONICS and PGHAC. Since the dtx BIOSONICS native file format structure is similar to HAC file format structure, BIOSONICS plans to make available a dtx to HAC file format converter. This development will be made at users request.

4.3.2 Compatibility of post-processing software

The list of tuples required for HAC compatibility has been updated; tuples 210 and 2100 were added in this list in 2005:

- 20 Geographic and time reference tuple
- 100 BioSonics Echosounder Tuple
- 200 SIMRAD EK500 Echosounder Tuple
- **210 SIMRAD EK60 Echosounder Tuple**
- 901 Generic Echosounder Tuple – replaced previous version tuple 900
- 1000 BioSonics Channel Tuple
- 2000 SIMRAD EK500 Channel Tuple – original
- 2001 SIMRAD EK500 Channel Tuple – revised: 1) add Surface Blanking range 2) Save 2 dec. for angle offsets and 3dB beamwidth
- 2002 SIMRAD EK500 Channel Tuple patch tuple – Addition of both Sv and TS transducer gains
- **2100 SIMRAD EK60 Channel Tuple**
- 9001 Generic Channel Tuple– replaced previous version tuple 9000
- 10000 Standard Ping U32 – Time series of data samples Uncompressed 32-bit sample format range
- 10001 Ping U-32-16-angles Time series of split-beam off-axis angle sample data. Uncompressed 32-bit sample format range
- 10010 Ping C32 – Time series of samples. Compressed 32-bit sample format range
- 10011 Ping C-32-16-angles Time series of compressed split-beam off-axis angle sample data. Compressed 32-bit sample format range
- 10030 Ping U-16 – Time series of data samples. Uncompressed 16-bit sample format range
- 10031 Ping U-16-angles Time series of split-beam off-axis angle sample data. Uncompressed 16-bit sample format
- 10040 Ping C-16. Time series of samples. Compressed 16-bit sample format range:
- 10100 General threshold - Constant and time-varied threshold
- 65534 End of file
- 65535 HAC signature

The following table represents the ability of some of the currently available data acquisition and analysis software to read and write the above list of tuples and therefore their HAC compatibility

Tuple number	DATA ACQUISITION/PROCESSING SOFTWARE			
	CH1(ver. 3.3.9)	CH2(ver 2.3.7)	Echoview** (ver 3.35)	Movies+ (ver. 4.3)
20	W	R	RW	RW
100	W	R	R	
200	W	R	R	RW
210	N/A	R		R
901	N/A	R*	RW	RW
1000	W	R	R	
2000	W	R	R	R
2001	W	R	R	RW
2002	W	R		RW
2100	N/A	R		R
9001	N/A	R*	RW	RW
10000	W	R	RW	R
10001	W	R	RW	
10010	W	RW	R	R
10011	W	RW	RW	
10030		R		R
10031		R		
10040	W	R	RX	RW
10100	W	R	R	RW
65534	W	R	RW	RW
65535	W	R	RW	RW

* Represents implementation planned for 2005/2006 – **Bold** represents new to standard

** An up to date list of supported tuples in Echoview can be obtained from http://www.sonardata.com/WebHelp/Reference/File_formats/HAC_data_files.htm

5 Recommendations

It was agreed that the **Planning Group on the HAC Data Exchange Format (PGHAC)** should continue to work by correspondence under the Chairmanship of L. Berger, IFREMER, France. The proposed Terms of Reference are:

- a) coordinate the further development of the HAC standard data exchange format;
- b) provide information on the changes in the format and its evolution;
- c) share information between manufacturers and users on the way acoustic data are processed and stored;
- d) review the final version of tuples for multi-beam echosounders;
- e) review the development of a tuple for acoustic trawl geometry instruments.

If needed, the PGHAC will meet during next WGFASST meeting in Hobart, Tasmania, in March 2006.

6 References

- McQuinn, I.H., D. Reid, L. Berger, N. Diner, D. Heatley, I. Higginbottom, L.N. Andersen, O. Langeland, J.P. Lapierre 2005. Description of the ICES HAC Standard Data Exchange Format, Version 1.60.
- Simard, Y., I. McQuinn, N. Diner, and C. Marchalot. 1999. The world according to *HAC*: summary of this hydroacoustic standard data format and examples of its application under diverse configurations with various echosounders and data acquisition software. ICES-Fisheries Acoustics Sciences and Technology meeting, St. John's, Newfoundland, Canada, 20–22 April 1999, Working paper. 14 pp.
- Simard, Y., I. McQuinn, M. Montminy, C. Lang, D. Miller, C. Stevens, D. Wiggins and C. Marchalot. 1997. Description of the *HAC* standard format for raw and edited hydroacoustic data, version 1.0. Can. Tech. Rep. Fish. Aquat. Sci. 2174: vii + 65 pp.

Annex 1: List of participants

List of participants of the Planning Group on the HAC Data Exchange Format

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Annex 2: Action Plan Progress Review

Year	Committee Acronym	Committee name	Expert Group	Reference to other committees	Expert Group report (ICES Code)	Resolution No.		
2004/2005	FTC	Fisheries Technology Committee	PGHAC	WGFAST	2005/B/09	2B09		
Action Plan	Action Required	ToR's	ToR	Satisfactory Progress	No Progress	Unsatisfactory Progress	Output (link to relevant report)	Comments (e.g., delays, problems, other types of progress, needs, etc.
No.	Text	Text	Ref. (a, b, c)	S	0	U	Report code and section	Text
1.12.5	Improved application of technology to surveys and monitoring;	coordinate the further development of the HAC standard data exchange format;	a)	X			2005/B/09 section 3.2	
1.13.1	Improve the standardisation and performance of survey gears.	coordinate the further development of the HAC standard data exchange format;	a)	X			2005/B/09 section 3.2	
1.13.3	Implement a common data format in acoustics for scientists and industry.	coordinate the further development of the HAC standard data exchange format;	a)	X			2005/B/09 section 3.2	
1.13.5	Establish and evaluate a framework for the collection of hydroacoustic and ancillary data from commercial fishing vessels.	coordinate the further development of the HAC standard data exchange format;	a)		X			Actual format can be used
5.4	Develop guidelines and standards for the participation of partners outside the traditional network of ICES- collaborating laboratories in monitoring programmes (such as RV surveys) that underpin on-going ICES science programmes.	coordinate the further development of the HAC standard data exchange format;	a)		X			
1.12.5	Improved application of technology to surveys and monitoring;	provide information on the changes in the format and its evolution;	b)	X			2005/B/09 section 3.1	
1.13.1	Improve the standardisation and performance of survey gears.	provide information on the changes in the format and its evolution;	b)	X			2005/B/09 section 3.1	
1.13.3	Implement a common data format in acoustics for scientists and industry.	provide information on the changes in the format and its evolution;	b)	X			2005/B/09 section 3.1	
1.13.5	Establish and evaluate a framework for the collection of hydroacoustic and ancillary data from commercial fishing vessels.	provide information on the changes in the format and its evolution;	b)		X			
5.4	Develop guidelines and standards for the participation of partners outside the traditional network of ICES- collaborating laboratories in monitoring programmes (such as RV surveys) that underpin on-going ICES science programmes.	provide information on the changes in the format and its evolution;	b)	X			2005/B/09 section 3.1	
5.11	Consult with and provide technical advice to the fishing industry and fisheries management agencies in the development of technical devices to be used in harvesting technology and the modernisation of the methods and technologies currently used in the enforcement of technical measures.	share information between manufacturers and users on the way acoustic data are processed and stored;	c)	X			2005/B/09 section 3.3	
5.12	Provide advice on research design and in some cases participate in projects with research and development agencies in the acoustic and the fishing technology industries.	share information between manufacturers and users on the way acoustic data are processed and stored;	c)	X			2005/B/09 section 3.3	
1.12.5	Improved application of technology to surveys and monitoring;	review and report on the new collated HAC specification manual;	d)	X			2005/B/09 section 3.1	
1.13.1	Improve the standardisation and performance of survey gears.	review and report on the new collated HAC specification manual;	d)	X			2005/B/09 section 3.1	
1.13.3	Implement a common data format in acoustics for scientists and industry.	review and report on the new collated HAC specification manual;	d)	X			2005/B/09 section 3.1	
1.13.5	Establish and evaluate a framework for the collection of hydroacoustic and ancillary data from commercial fishing vessels.	review and report on the new collated HAC specification manual;	d)		X			Based on this document sounder manufacturer for fishing vessels will be able to use the format for collecting of hydroacoustics and ancillary data.
5.4	Develop guidelines and standards for the participation of partners outside the traditional network of ICES- collaborating laboratories in monitoring programmes (such as RV surveys) that underpin on-going ICES science programmes.	review and report on the new collated HAC specification manual;	d)	X			2005/B/09 section 3.1	Practical achievement of this year: the new documented version of HAC format is useful for any collaborating project in fishery using acoustics
1.12.5	Improved application of technology to surveys and monitoring;	review and report on the development of tuples for multi-beamechousnders.	e)	X			2005/B/09 section 3.2	
1.13.1	Improve the standardisation and performance of survey gears.	review and report on the development of tuples for multi-beamechousnders.	e)		X			the use of multibeam echousnders in biomass estimation will become a reality in the next years, for the time being this technology/methodology is in development.
1.13.3	Implement a common data format in acoustics for scientists and industry.	review and report on the development of tuples for multi-beamechousnders.	e)		X			
1.13.5	Establish and evaluate a framework for the collection of hydmacoustic and ancillary data from commercial fishing vessels.	review and report on the development of tuples for multi-beamechousnders.	e)		X			
5.4	Develop guidelines and standards for the participation of partners outside the traditional network of ICES- collaborating laboratories in monitoring programmes (such as RV surveys) that underpin on-going ICES science programmes.	review and report on the development of tuples for multi-beamechousnders.	e)		X			theexistence of a standard data format for these new equipment will make it easier to be used in routine